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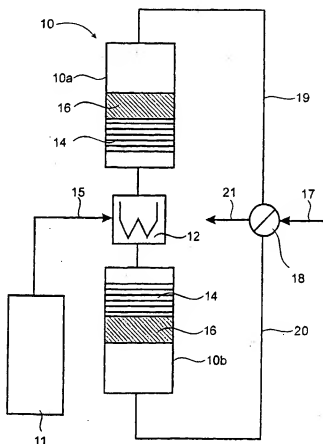
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(54) Title: METHOD AND DEVICE FOR PROCESSING NITROGEN-BASED GASES



(57) Abstract: A method and a device for processing nitrogen-based gases, such as ammonia and amines, by means of a catalyst. The gas is brought into contact with a zeolite catalyst and an oxidation catalyst. The catalysts are provided in a reactor (10, 30) having an inlet (15, 35) for the nitrogen-based gas, and an outlet (21, 36) for the purified gas.

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METHOD AND DEVICE FOR PROCESSING NITROGEN-BASED GASES

## TECHNICAL FIELD OF THE INVENTION

5           The present invention relates to a method used for processing nitrogen-based gases containing compounds such as ammonia and amines. The method is adapted to purifying exhaust, process gases, ventilation air and similar. The purpose of the purification may be to prevent emission of small amounts of malodorous substances, so called odourants, or to simply obliterate large amounts. Emissions of nitrogen-based odourants interferes with  
10           the environment because the compounds are perceived even in low concentrations. During the catalytic purification, decomposition of amines into ammonia first takes place followed by selective oxidation of ammonia into gaseous nitrogen and water.

15           The present invention also relates to a device for processing such nitrogen-based gases by the means of a catalyser comprising a zeolite catalyser and an oxidation catalyser. The present invention also relates to a method for manufacturing such device.

## STATE OF THE ART

20           There are three methods when it comes to purification of gases containing nitrogen-based odourants. The methods are: absorption, adsorption, and oxidation.

25           During absorption the gas is treated with an acid solution in a scrubber. The odourant is absorbed in the liquid resulting in a clean gas. The absorption liquid is recirculated until it is considered to be consumed and should then be destroyed in a suitable fashion.

30           During adsorption the gas passes through a solid adsorption material such as active coal. The adsorption material is impregnated with an acid, metal ions, etc. to enhance the adsorption capacity so as to better bind the basic gases. Once consumed the adsorption material must be destructed or restored in a suitable manner.

Oxidation can be carried out either in a noncatalytic way by conducting the gases through a flame, or catalytically. For a catalytic oxidation the same metal oxide based or precious metal based catalyser is used as for reduction of VOC, i.e. volatile hydrocarbons.

- 5        Oxidation, both catalytically and noncatalytically, of nitrogen-containing compounds are effective, i.e. the odourants stop smelling. The odourants are, however, to a large extent oxidised to nitrogen oxides (NOx) and nitrous oxide (N<sub>2</sub>O). The development of these gases depends on the choice of catalyser, concentration and temperature. It is possible to oxidise ammonia  
10 to NOx with high selectivity across a precious metal catalyser, which is the industrial way for the production of nitric acid. The desired product, however, as far as oxidation of nitrogenous odourants is concerned, is nitrogen gas (N<sub>2</sub>). The selectivity for nitrogen gas in the case of the above-mentioned catalysers is poor. When they are used nitrogen oxides and laughing gas are  
15 always developed. Neither NOx or laughing gas is a desired product in a purification plant.

- Nitrogen oxides contribute to the global acidification, smog and formation of near ground ozone. In addition, nitrogen oxides are acutely toxic and may cause damage to the respiratory passages. The harmful effects of the  
20 nitrogen oxides have resulted in actions taken to limit emissions of them. Such exemplary actions are 3-way catalysis for cars and SCR technology at power plants. Laughing gas, N<sub>2</sub>O, currently is unregulated but is considered to be hazardous to the environment due, on the one hand, to its participation in disintegrating the ozone layer of the stratosphere and, on the other hand,  
25 to its effect as a greenhouse gas.

- In the prior art there are also described methods and devices for processing gases containing nitrogen by the means of a catalyser comprising zeolite. One example of such method and device is disclosed in WO 9816300. WO 9816300 discloses a catalyser with a catalytic bed consisting  
30 of a zeolitic catalyser in the form of an extrudate. The catalyser further comprise several oxidation nets, placed above and beneath the extrudate in the reactor, forming oxidation top nets and bottom oxidation nets.

One drawback with the device described in WO 9816300 is that it is rather large compared to the efficiency. Another drawback with prior art is the ungainly structure due to the different catalyser sections, the catalyser comprising both extrudates and catalytic nets. It is also problematic selecting the proper size of the oxidation top net used in prior art since the size depends on gasload and temperature. If the oxidation top net is designed for one flow and one temperature, the operation of the oxidation top net will turn poorer if one or both parameters is changed.

One problem with using extrudates is that they consist of homogenous material, which require a large amount of active material. Devices according to prior art are thus expensive due to the different catalyser sections and the large amount of active material required in the extrudate. Still another drawback with such methods and devices is the high energy consumption, due to the high processing temperature. Several of the drawbacks and problems are particularly unfavourable for domestic applications.

#### SUMMARY OF THE INVENTION

One object of the present invention is to eliminate the above mentioned drawbacks and problems with methods and devices for processing nitrogen-based gases described in the prior art. The present invention provides an efficient method and device for purifying such malodorous gases with high selectivity for nitrogen gas ( $N_2$ ) formation. One embodiment of the present invention is excellent for industrial applications. One alternative embodiment is well adapted to domestic applications as well as industrial applications. Further, the present invention provides a method for the manufacturing of a catalyser well adapted to the applications.

The present invention comprises a process tank, a heater and a reactor comprising a catalyser. The process tank is adapted to contain a material emitting the nitrogen-based gas to be processed.

In one embodiment of the invention the gas to be processed is conducted to the heater, the heater being arranged between a first reactor com-

partment and a second reactor compartment in a regenerative reactor. Thus, the nitrogen-based gas is introduced in the reactor between the first reactor compartment and the second reactor compartment and is heated by the heater to suitable processing temperature. The reactor compartments also  
5 comprise a catalyser and a recuperator or devices with similar function.

The reactor is connected to an air inlet via a first tubing and a second tubing, wherein an air flow may be introduced to the reactor in alternating directions by the means of a valve. By introducing the air flow to the reactor in one direction the nitrogen-based gas is brought into contact with one cata-  
10 lyser. For example, by introducing the air flow via the first tubing the nitrogen-based gas is brought into contact with the catalyser of the second reactor compartment absorbing and purifying the nitrogen-based gas. The heat energy is recovered in the recuperator. The purified gas follow the air flow to the valve via the second tubing, the valve comprising an outlet for the puri-  
15 fied gas and the air.

When the direction of the air flow is changed, i.e. introducing the air flow to the reactor via the second tubing, the nitrogen-based gas remaining in the second reactor compartment and the new nitrogen-based gas introduced in the reactor is transported towards the first reactor compartment.  
20 The first reactor compartment may be designed as the second reactor compartment, comprising the catalyser purifying the nitrogen-based gas. The catalyser is described in more detail below. The purified gas follow the air flow to the outlet via the recuperator and the first tubing.

By alternating the direction of the air flow the heated nitrogen-based  
25 gas is transported between the first reactor compartment and the second reactor compartment, the nitrogen-based gas and the heat energy being trapped in the catalyst area. This imply an effective process for purifying nitrogen-based gas at low consumption of energy and consequently at low costs. The processing temperature may be selected almost without consider-  
30 ing the costs for heating since the heat energy is trapped in the catalyst area. For example the processing temperature is about 400-500°C.

One further advantage with this embodiment of the present invention is that only purified gas and air exits via the outlet, even when the direction of the air flow is changed.

Another advantage with this embodiment is that the dwell time for the  
5 nitrogen-based gas in the catalyser is indefinite.

In one alternative embodiment, the process tank is connected to a heat exchanger, designed to heat the nitrogen-based gas by means of purified gas from an outlet of the reactor. The heat exchanger is connected to an  
10 inlet of the reactor via the heater, the heater being designed to heat the nitrogen-based gas to proper processing temperature. For example the heater is designed to heat the nitrogen-based gas to about 350°C.

The reactor is provided with the catalyser, the catalyser being described in more detail below. The nitrogen-based gas is brought into contact  
15 with the catalyser, purifying the nitrogen-based gas.

The catalyser comprise at least one catalytic net. The nets may be coated with a porous and preferably ceramic material through a thermal forming process by spraying. The nets are preferably coated with titanium  
20 dioxide (TiO<sub>2</sub>) or another suitable substance. Several catalytic nets may be arranged in the reactor to obtain proper conversion and selectivity.

The catalytic net comprise a zeolite promoted with a precious metal, such as rhodium (Rh), platinum (Pt) and palladium (Pd), combining ammonia reduction properties with oxidation properties. Preferably the precious metal  
25 is Rh. Pt and Pd promotion gives similar increase in activity, but Rh gives superior selectivity towards nitrogen formation.

It is now proven feasible to catalytically oxidise, with high selectivity, nitrogen-containing odourants, such as ammonia and trimethylamine, to nitrogen gas and water. The gases containing the odourant pass through at  
30 least one catalytic net, which consists of a zeolitic catalyser of the H-mordenite type, and an oxidation catalyser. The oxidation catalyser is combined with the zeolitic catalyser in the same catalytic net. The gases are

preferably processed at a temperature of about 400-500°C in one embodiment and about 350°C in one alternative embodiment. These embodiments will result in a technically speaking reasonable size of reactor and a very good selectivity for nitrogen gas formation.

- 5 For example, the catalytic nets are prepared by milling zeolite with a binder and water in a ball mill, producing a slurry. Zeolites are crystalline alumina silicates, usually produced in a crystal size of 50-100  $\mu\text{m}$  and available either as powder or as extrudates. To make extrudates, the zeolite powder is mixed with a binder, usually a silica or alumina based binder. Both
- 10 zeolite powder and grounded extrudates may be used as source of zeolite. The zeolite is grounded into a crystal size of about 2  $\mu\text{m}$ .

- As binder colloidal alumina, silica or sodium silicate may be used. Preferably an alumina based slurry is used. The catalytic nets are then prepared by spraying, washcoating or dipping the nets in the slurry, producing a
- 15 thin film of active material on the surface of the nets. Preferably the nets are coated with slurry by spraying. If required the catalytic nets may be coated repeatedly to obtain a certain amount of slurry on the net. The zeolite is, as mentioned above, then promoted with a precious metal. For example, the net may be dipped in a solution containing the precious metal.

- 20 Compared to the extrudates, consisting of homogenous material, the amount of active material required is only a small fraction, which reduces the costs.

- In one embodiment of the invention at least one bottom oxidation net is also arranged in the reactor. The bottom oxidation nets may be coated
- 25 with a porous and preferably ceramic material through a thermal forming process by spraying. The bottom oxidation nets may be surface area enlarged through sol treatment and coated with an active material having oxidation properties, such as precious metals Pt, Pd or metal oxides. Besides varying the layer formed by spraying, the surface area enlarging and
- 30 the active phase, the properties of the bottom oxidation nets can be varied by electing an appropriate wire thickness and mesh size.

The ammonia entering the catalyser is oxidised with surprisingly high selectivity to become nitrogen gas and water.

When odourants of the amine type enter the catalyser they decompose into ammonia and, presumably, into corresponding alcohol. This step, already, reduces the problem with odour to a large extent because the ammonia odour threshold is significantly higher than that of amines. The ammonia oxidation then occurs as indicated above. The oxidation of amines, however, takes place at a lower rate and with a considerably lower selectivity to become nitrogen gas, that is the formation of nitrogen oxides and laughing gas is greater, than during oxidation of ammonia alone. By the operation of the catalytic nets in the reactor the amine rate of oxidation is substantially increased. At the same time, a quite unexpected improvement of the selectivity to yield nitrogen gas is achieved due to decreased formation of laughing gas. The introduction of catalytic oxidation properties in the nets has the additional effect of oxidising any incoming hydrocarbons to carbon dioxide and water. If additional bottom oxidation nets are placed after the catalytic nets, final combustion occurs of hydrocarbons (VOC) that are not oxidised in the catalytic nets.

In addition, this invention has the advantageous feature in common with other oxidising systems, when it comes to adsorption and absorption systems, that no solid or liquid waste is formed.

The invention has, in comparison with other oxidising systems, very high selectivity for formation of nitrogen gas utilised in the ammonia oxidation.

Compared to other oxidising systems, the present invention has a high selectivity for formation of nitrogen gas utilised in the amine oxidation.

The invention also requires substantially less active material and allows a simple construction able to process nitrogen-based gases at a lower temperature and/or with a lower energy consumption than prior art. These features result in a smaller and cheaper construction, without obtaining inferior purifying properties.

A good effect is achieved with catalyst material being in the form of zeolites having a low silicon to aluminium ratio. An unusually good effect is achieved with a silicon to aluminium ratio being lower than 20, especially in the range of 5-20. In this interval there is mordenite, primarily an H mordenite. For example, a good effect can be attained also with a  $\beta$ -zeolite when the silicon to aluminium ratio is higher than for example 12. For certain applications, zeolites with a silicon to aluminium ratio higher than for example 20 may also be used. For example, a suitable zeolite would then be ZSM-5.

The properties of the zeolites may change through an ion exchange with metal ions. Depending on what metal ion or ions that are used, different characteristics will be achieved. Alkaline metal ions, for example Na and K, lead to loss of the activity. Exchange of copper ions into the zeolite results in a strongly increased activity at the same time as the selectivity for the formation of nitrogen gas continues to be good. Other metal ions with good properties include Ce and Fe.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail with the aid of exemplary embodiments and with reference to the accompanying drawings, in which

Fig. 1 is a principal block diagram illustrating one embodiment of the invention,

Fig. 2 is a principal block diagram illustrating one alternative embodiment of the invention,

Fig. 3 is a diagram showing the conversion of ammonia using zeolite nets,

Fig. 4 is a diagram showing the conversion of ammonia using zeolite nets promoted with rhodium, and

Fig. 5 is a diagram showing the selectivity of zeolite nets promoted with rhodium.

## DESCRIPTION

The block diagram of Fig. 1 shows a principal layout of a regenerative process device according to one embodiment of the present invention. The present invention comprise a reactor 10, a process tank 11 and a heater 12.

The process tank 11 is designed to contain a material emitting odourants such as nitrogen-based gases. In the process tank 11, amines and ammonia or other compounds which are to be treated are generated. The process tank 11 is connected to the heater 12 adapted to heat the nitrogen-based gas or compound to suitable processing temperature. For example the nitrogen-based gas is heated to about 400-500°C. Preferably the heater 12 is arranged between a first reactor compartment 10a and a second reactor compartment 10b. The nitrogen-based gas is then conducted to the reactor compartments 10a, 10b, respectively.

For example the reactor 10 is designed as a longish cylinder with a principally circular cross section. The reactor 10 comprise an inlet 15 for nitrogen-based gas to be processed, the first reactor compartment 10a and the second reactor compartment 10b.

The reactor compartments 10a, 10b comprise a catalyser and a recuperator 16. The catalyser comprise a zeolite catalyser and an oxidation catalyser arranged as a catalytic net 14. The reactor compartments 10a, 10b comprise at least one catalytic net 14. Preferably several catalytic nets 14 are arranged in the reactor compartments 10a, 10b. The catalytic nets 14 are arranged between the heater 12 and the recuperator 16. The nitrogen-based gas, heated by the heater 12, is brought into contact with the catalytic nets

14, purifying the nitrogen-based gas. The catalytic nets 14 are described in more detail below.

The recuperator 16 is designed to recover the heat energy from the heated gases in the reactor 10. For example the recuperator 16 comprise a material with good thermal transmittance properties.

The reactor compartments 10a, 10b are connected to an air inlet 17, designed for introducing an air flow, via a valve 18. The first reactor compartment 10a is connected to the valve 18 by the means of a first tubing 19 and the second reactor compartment 10b is connected to the valve 18 by the means of a second tubing 20. The valve 18 is designed for alternating the direction of the air flow, alternating the air flow into the first tubing 19 and the second tubing 20. The valve 18 also comprise an outlet for purified gas and air. The air flow, introduced through the air inlet 17 and conducted via the valve 18 and the tubings 19,20 to the reactor 10, transports the nitrogen-based gas and the purified gas in the same direction as the air flow. For example the air flow is about ten times the nitrogen-based gas introduced in the reactor 10.

For example, by introducing the air flow via the first tubing 19 the nitrogen-based gas is brought into contact with the catalytic nets 14 of the second reactor compartment 10b absorbing and purifying the nitrogen-based gas. The heat energy is recovered in the recuperator 16 of the second reactor compartment 10b. The purified gas follow the air flow to the valve 18 via the second tubing 20, the valve 18 comprising the outlet 21 for the purified gas and the air.

When the direction of the air flow is changed by the means of the valve 18, i.e. introducing the air flow to the reactor 10 via the second tubing 20, the nitrogen-based gas remaining in the second reactor compartment 10b and the new nitrogen-based gas introduced in the reactor 10 through the inlet 15 is transported towards the first reactor compartment 10a. The catalytic nets 14 of the first reactor compartment 10a purifying the nitrogen-based gas. The purified gas follow the air flow to the outlet 21 via the recuperator 16 of the first reactor compartment 10a and the first tubing 19.

By alternating the direction of the air flow by the means of the valve 18, the heated nitrogen-based gas is transported between the first reactor compartment 10a and the second reactor compartment 10b, the nitrogen-based gas and the heat energy being trapped in the catalyst area.

- 5 In one embodiment of such regenerative process device, the reactor compartments 10a, 10b each comprise 36 catalytic nets 14. The recuperator 16 comprise 6,5 kg material with good thermal transmittance properties and the air flow is 40 m<sup>3</sup>/h. During experimental studies of such device, injecting 200 ml/h of a 25% NH<sub>3</sub>-solution resulted in no detectable odourants. Only  
10 about 5-6 ppm N<sub>2</sub>O was detected.

- The block diagram of Fig. 2 shows a principal layout of a recuperative process device according to one alternative embodiment of the present invention. The present invention comprise a reactor 30, a process tank 31, a  
15 heat exchanger 32 and a heater 33. A catalyser is arranged in the reactor 30.

- The process tank 31 is designed to contain a material emitting nitrogen-based gases. In the process tank 31, amines or other gases which are to be treated are generated. The process tank 31 is connected to a heat exchanger 32 adapted to heat the nitrogen-based gases by the means of purified gas from the reactor 30. The gases are conducted via the heat exchanger 32 to the heater 33, in which the gases are heated to a suitable  
20 processing temperature. For example the gases are heated to about 350°C. On heating of the gas in the heater 33, it is conducted into the reactor 30 containing a catalyser. Purified gas is sucked out from reactor 30 via heat exchanger 32 by means of a suction fan 34.

- The reactor 30 has an inlet 35 for those gases that are to be processed, and an outlet 36 for the processed gases. The catalyser comprise at least one catalytic net 14, provided in the reactor 30. The number of catalytic  
25 nets 14 arranged in the reactor 30 depends on the application.

If the catalyst is operated at 350°C, a gasload of 10 Nd<sup>3</sup>/min on 10 catalytic nets with 16 mesh and 30 mm in diameter are required to obtain a

sufficient purification of the nitrogen-based gases. This is equal to  $85 \text{ Nm}^3/(\text{h m}^2)$ . To a  $75 \text{ Nm}^3/\text{h}$  unit, the catalyst needed is less than one square meter. Preferably 10 catalytic nets 14 are arranged in the reactor 30.

5 In one embodiment at least one bottom oxidation net 22 is arranged in the reactor 30 between the catalytic nets 14 and the outlet 36. Preferably two bottom oxidation nets 22 are arranged in the reactor 30. Preferably 8 catalytic nets 14 and 2 bottom oxidation nets 22 are used in a reactor 30 with a diameter of 400 mm when the conditions are as described above.

10 The catalytic net 14 may be coated with a substance such as  $\text{TiO}_2$  through a thermal forming process by spraying, providing the catalytic net 14 with a surface appropriate for catalytic active material. The catalytic net 14 further comprise a zeolite catalyst promoted with a precious metal, such as rhodium, platinum and palladium. Preferably the precious metal is rhodium.

15 The catalytic net 14, for example coated with  $\text{TiO}_2$ , is coated with the zeolite by spraying, washcoating or dipping the catalytic net 14 in a slurry containing the zeolite. The slurry is prepared by mixing the zeolite with a binder, such as alumina and silica binders, and water. The zeolite, which preferably is a zeolite powder, is grounded to a crystal size of approximately  $2 \mu\text{m}$ . The mixing

20 and grinding is, for example, performed in a mill, such as a ball mill.

Fig. 3 shows the results from one experimental example of processing ammonia by the means of zeolite nets. Pre-prepared extruded catalyst was grinded in a ball mill with water for 24 h until a smooth slurry was obtained.

25 The slurry was mixed with 30 wt% binder ( $\text{Al}_2\text{O}_3 + \text{SiO}_2$ ). The used nets was 10 mesh, 0,8 mm thread and sprayed with  $\text{TiO}_2$ . The nets were immersed in the slurry, blown with compressed air and dried in a hot air oven ( $150^\circ\text{C}$ ). This procedure was repeated 5 times. The catalyst was then calcined at  $500^\circ\text{C}$  for 1h. The deposited amount was about  $250 \text{ g per m}^2$  net. 10 pieces of

30 32 mm in diameter circular nets, for a laboratory quartzreactor, was prepared.

The experiments was carried out in the quartz reactor (32 mm in diameter) at 10 dm<sup>3</sup>/min (STP). This flow corresponds to a space velocity of 57.000 h<sup>-1</sup> (10 l/min) for the net pack (32 mm in diameter and 15 mm high). 360 ppm of ammonia was injected into the pressurised gas flow. The conversion at a space velocity of 6000 h<sup>-1</sup> was calculated.

Fig. 4 and Fig. 5 shows the results using catalytic nets 14, i.e. zeolite nets promoted with rhodium, processing ammonia. A small batch of slurry used in this experimental study was obtained according to the following procedure: 50 g zeolite powder of H mordenite type was mixed with 20 g of cerium nitrate (Ce(NO<sub>3</sub>)<sub>2</sub> × 6 H<sub>2</sub>O), 15 g of 30 weight% colloidal silica (Bindizil 30/NH<sub>3</sub> 220) and 100 ml of distilled water in a ball mill. The slurry was then grounded for 12 hours.

The nets 14 were prepared by dipping in the slurry, left to drip off, blown with pressurised air and dried at 150°C in a hot air oven. This was repeated until at least 300 g/m<sup>2</sup> was deposited on the net. The net was then calcined at 500°C for 12 hours.

To promote the catalytic net 14, comprising zeolite, with a precious metal, the catalytic nets 14 were dipped in a 0.02 M solution of RhCl<sub>3</sub>, dried at 150°C and then calcined at 500°C for 1 hour. 10 catalytic nets 16 mesh and 30 mm in diameter were used.

The bottom oxidation nets 22 may be coated with a porous and preferably ceramic material through a thermal forming process by spraying. The bottom oxidation nets 22 may be surface area enlarged through sol treatment and coated with an active material having oxidation properties, such as precious metals Pt, Pd or metal oxides. Besides varying the layer formed by spraying, the surface area enlarging and the active phase, the properties of the bottom oxidation nets 22 can be varied by electing an appropriate wire thickens and mesh size.

Alternatively, the bottom oxidation nets 22 may be arranged similar to the catalytic nets 14, i.e. with zeolite and Rh.

## PATENT CLAIMS

1. A method used for processing nitrogen-based gases, such as ammonia  
5 and amines, with a catalyser comprising zeolite, comprising the steps of  
bringing the nitrogen-based gas into a reactor (10),  
heating the nitrogen-based gas to proper processing temperature,  
bringing the heated nitrogen-based gas into contact with the  
10 catalyser, arranged in the reactor (10), comprising at least one catalytic net  
(14) coated with zeolite,  
oxidizing the nitrogen-based gas to nitrogen gas and water by  
the means of the at least one catalytic net 14, and  
alternating the flow direction of the nitrogen-based gas over the  
15 catalyst area, keeping the heated nitrogen-based gas in the catalyst area.
2. A method according to claim 1, further including the step of introducing  
the nitrogen-based gas in the reactor (10) between a first reactor compartment  
(10a) and a second reactor compartment (10b), each of said reactor  
20 compartment (10a, 10b) comprising the at least one catalytic net (14).
3. A method according to claim 2, further including the step of alternating the  
flow direction of the nitrogen-based gas by the means of an air flow.
- 25 4. A method used for processing nitrogen-based gases, such as ammonia  
and amines, with a catalyser comprising zeolite, comprising the steps of  
bringing the nitrogen-based gas into a reactor (30) via a heat exchanger (32),  
outlet gas from the reactor (30) heating the nitrogen-based  
30 gas, and a heater (33) for further heating the nitrogen-based gas to proper  
processing temperature,

bringing the nitrogen-based gas into contact with the catalyser, arranged in the reactor (30), comprising at least one catalytic net (14) coated with zeolite, and

oxidizing the nitrogen-based gas to nitrogen gas and water by  
5 the means of the at least one catalytic net (14).

5. A method according to claim 4, wherein the zeolite is promoted with a precious metal.

10 6. A method according to claim 5, wherein the precious metal is rhodium.

7. A method according to claim 6, further including the step of bringing the nitrogen-based gas into contact with at least one bottom oxidation net (22) after being brought into contact with the at least one catalytic net (14).

15

8. A method according to claim 6, further including the step of heating the nitrogen-based gas to a temperature of about 350°C.

20 9. A device for processing nitrogen-based gases, such as ammonia and amines, with a catalyser provided in a reactor (10, 30), having an inlet (15, 35) for the nitrogen-based gas, and an outlet (21, 36) for the purified gas, the catalyser comprising a zeolite catalyser and an oxidation catalyser, *characterised* in that the zeolite is provided on a catalytic net (14)  
25 and that the catalytic net (14) is also provided with a precious metal for oxidation of the nitrogen-based gas.

10. A device according to claim 9, wherein the precious metal is rhodium.

30 11. A device according to claim 10, wherein the catalyser comprise several catalytic nets (14).

12. A device according to claim 11, wherein the reactor (10) comprise a first reactor compartment (10a) and a second reactor compartment (10b), the reactor compartments (10a, 10b) comprising the catalytic nets (14) and a recuperator (16).

5

13. A device according to claim 11, wherein the catalyser also comprise at least one bottom oxidation net (22).

10

14. A method for manufacturing a catalytic net (14) for processing nitrogen-based gases, such as ammonia and amines, characterised by coating a net, comprising a porous ceramic material, with a zeolite catalyser, and promoting the zeolite with a precious metal.

15

15. A method according to claim 14, further comprising the step of coating the net with zeolite by spraying, washcoating or dipping the net in a slurry containing zeolite, binder and water.

20

16. A method according to claim 15, wherein the binder is an alumina based binder or a silica based binder.

25

17. A method according to claim 14, further comprising the step of promoting the zeolite with the precious metal by dipping the net in a solution containing the precious metal.

18. A method according to claim 14, wherein the precious metal is rhodium.

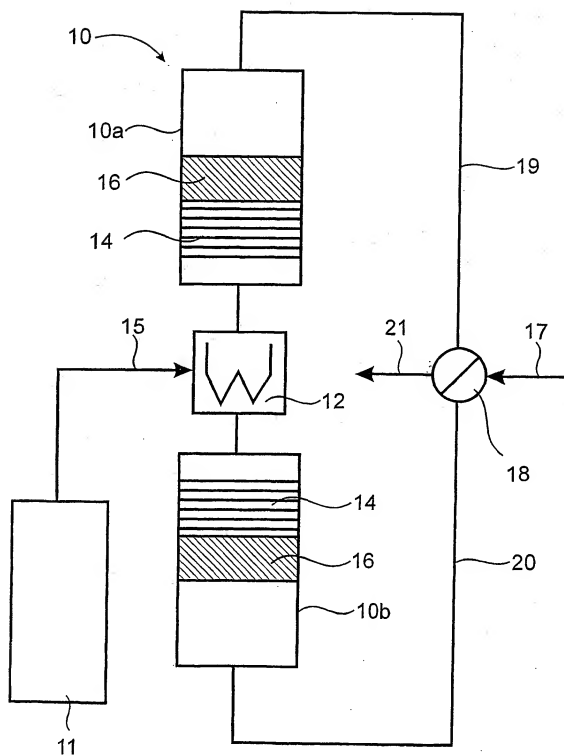


Fig. 1

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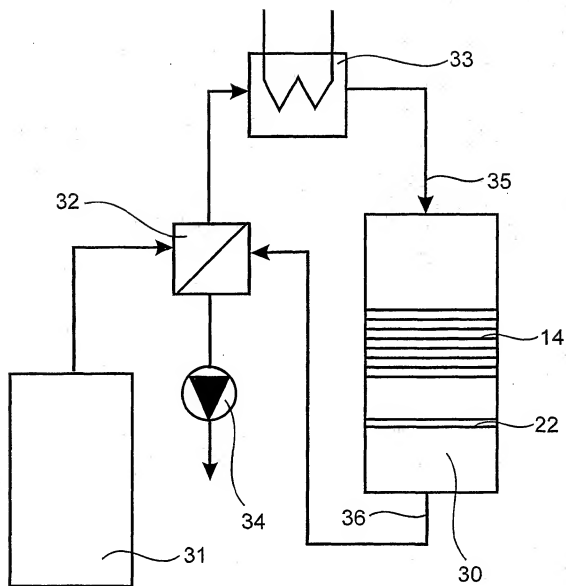


Fig. 2

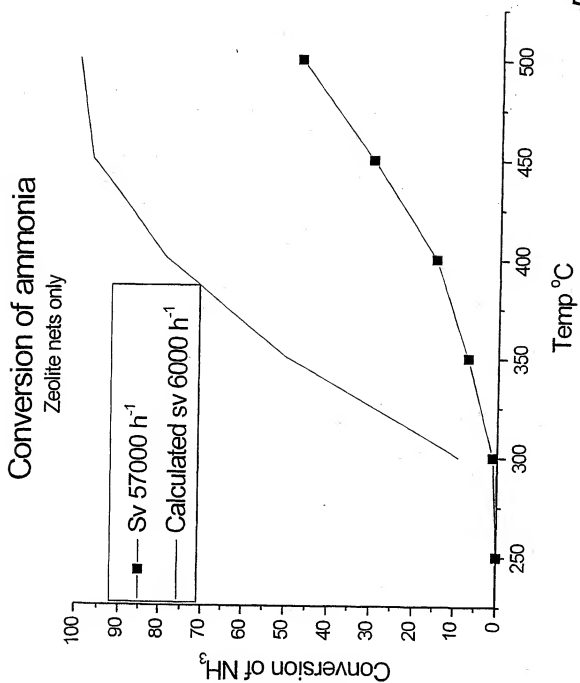


Fig. 3

4/5

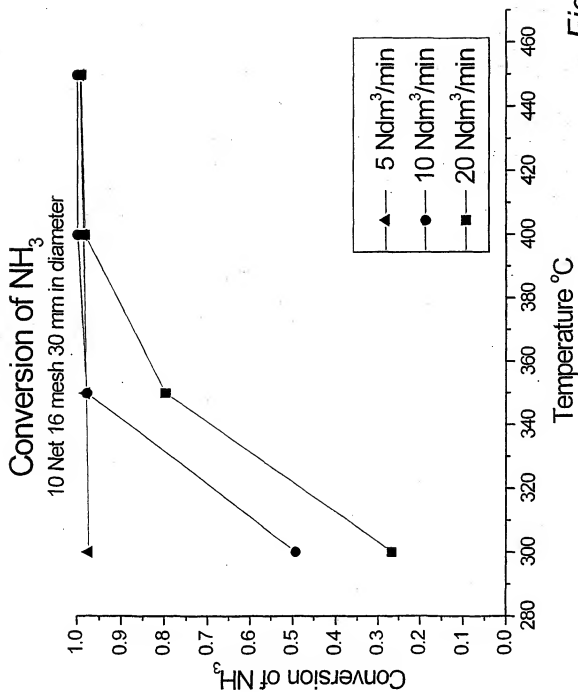


Fig. 4

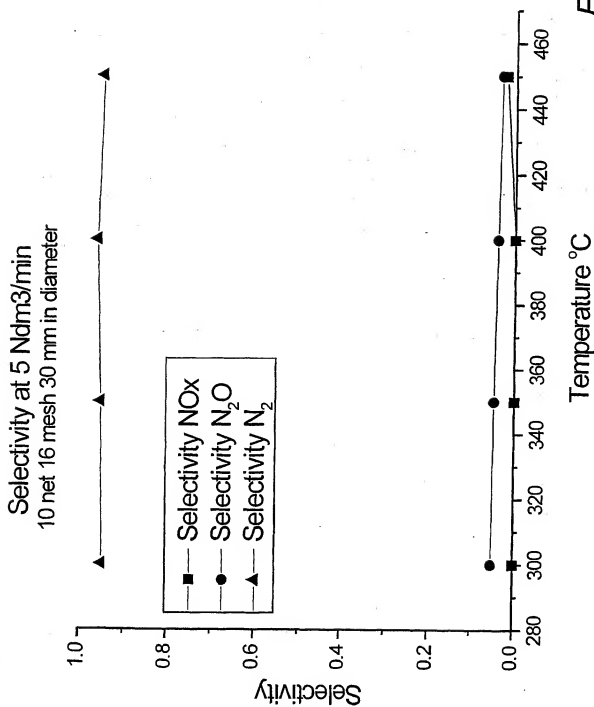


Fig. 5

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B01D 53/54, B01D 53/86

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B01D, B01J, F01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI DATA, EPO-INTERNAL, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim ...
X	WO 9816300 A1 (KATATOR AB), 23 April 1998 (23.04.98), page 6, line 8 - page 7, line 17, figure 1  --	1-18
X	US 4961917 A (BYRNE), 9 October 1990 (09.10.90), column 4, line 37 - line 56, claim 1, abstract  --	14-18
X	US 5041272 A (TAMURA ET AL), 20 August 1991 (20.08.91), column 1, line 46 - line 59  --	14-18

☒ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

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Date of the actual completion of the international search

14 August 2002

Date of mailing of the international search report

27 August 2002

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 5409681 A (KATO ET AL), 25 April 1995 (25.04.95), column 6, line 8 - line 12, claim 1, abstract  --	14-18
A	WO 9947245 A1 (HEED, BJÖRN), 23 Sept 1999 (23.09.99), page 4, line 13 - page 5, line 2, claims 1-2, abstract  -- -----	1-13

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06/07/02

International application No.

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